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Department of Water Resources

BULLETIN No. 172

EEL RIVER DEVELOPMENT ALTERNATIVES

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Director
Department of Water Resources

FOREWORD

In 1968 the Corps of Engineers submitted its report on the Dos Rios Project to the State of California for review. In May 1969, Governor Reagan expressed his concern about the flooding of Round Valley and the displacement of the Indian community and asked for a study of project alternatives.

This report is in response to the Governor's request and presents the results of the Department's study of alternative water developments within the Eel River Basin.

The report summarizes the cost and the water supply, flood control, and recreation accomplishments of the principal alternatives. In addition, the report contains discussions of some of the environmental effects of these alternatives, such as impact on fish and wildlife, land inundated, and people displaced.

The alternatives include easterly diversions through Glenn County and southerly diversions through Clear Lake. The Department is now involved in a reexamination of the routing issues, but studies have not progressed to the point where the results could be incorporated into this analysis of alternatives. Resolution of the routing question must await the results of the reexamination, scheduled for completion in the fall of 1970.

William R. Gianelli

William R. Gianelli, Director
Department of Water Resources
The Resources Agency
State of California
December 1, 1969

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(Published separately)

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State of California
The Resources Agency
DEPARTMENT OF WATER RESOURCES

RONALD REAGAN, Governor
NORMAN B. LIVERMORE, JR., Secretary for Resources
WILLIAM R. GIANELLI, Director, Department of Water Resources
JOHN R. TEERINK, Deputy Director
ALFRED R. GOLZE, Deputy Director

This report was prepared in the

NORTHERN DISTRICT

under the direction of

Gordon W. Dukleth . . . . . District Engineer

with the assistance of

DIVISION OF RESOURCES DEVELOPMENT

Herbert W. Greydanus . . . . . Division Engineer

and

DIVISION OF DESIGN AND CONSTRUCTION

Haywood G. Dewey, Jr. . . . . Division Engineer

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R. Dean Thompson, Executive Officer
C. A. McCullough, Engineer

ABSTRACT

Bulletin No. 172 presents the results of a special study of alternatives for Eel River development requested by Governor Reagan.

Six principal alternatives to the Corps of Engineers' proposed Dos Rios Project are identified. They involve three basic plans of Eel River development, each of which could be coupled with either an easterly diversion routing with holdover storage on Stony Creek, or a southerly routing through Clear Lake with holdover storage on Cache Creek.

The basic Eel River development plans involve (1) a small Dos Rios Reservoir which would not flood Round Valley, (2) a medium-sized Dos Rios Reservoir with auxiliary features to protect Round Valley, and (3) a Yellow Jacket Reservoir on the lower Eel River.

Each of the principal alternatives would provide at least 900,000 acre-feet of annual water supply at the Sacramento-San Joaquin Delta, but the alternatives would differ in flood control, recreation potential, local water yield, and environmental effects.

Costs, accomplishments, project descriptions, and a discussion of environmental effects are presented; secondary alternatives also are discussed.

FIGURE 1

EEL RIVER DEVELOPMENT ALTERNATIVES
DAMSITES CONSIDERED

SCALE OF MILES
0 8 16 24

INTRODUCTION

When the basic facilities of the State Water Project were being formulated in the 1950s, it was recognized that the initial conservation reservoirs (Oroville and San Luis) would be unable to sustain the required project yield on a long-term basis. In 1957, Bulletin No. 3, "The California Water Plan", identified the North Coast as the only remaining source of substantial surplus water supplies to meet future requirements in the State. A long-range reconnaissance investigation of the North Coastal area was begun immediately to determine the most logical plan for future water developments.

In 1960, the Burns-Porter Act launched the State Water Project; the Act included provisions for financing and repaying the costs of such additional conservation facilities as would be needed to meet long-term water contract commitments. In 1964, the Department's Bulletin No. 136, "North Coastal Area Investigation", recommended that the first additional conservation facility of the State Water Project be located on the Middle Fork Eel River. This recommendation was implemented in 1964 by departmental order designating the Upper Eel River Development as such additional facilities, and additional studies were begun to identify the specific features which would be constructed.

In 1966, the four agencies comprising the California State-Federal Interagency Group (the Bureau of Reclamation, the Corps of Engineers, the Soil Conservation Service, and the Department of Water Resources) adopted a joint program for water development planning in the Eel and Mad River Basins. The Middle Fork of the Eel River was assigned jointly to the Corps and the Department of Water Resources. In 1967, the Department recommended that future planning be concentrated on a dam at the Dos Rios site, and that further studies be conducted of reservoir sizing. Concurrently, the Corps concluded that a large Dos Rios Reservoir (which would inundate Round Valley) should be the initial basin development to provide flood control, water supply, and recreation.

On October 5, 1967, the Department entered into a memorandum of understanding with the Corps of Engineers under which the Corps would design, construct, and operate the Dos Rios Dam and Reservoir. The Department would contract for conservation storage under the Water Supply Act of 1958 and would construct the conveyance facilities to the Sacramento Valley.

In November 1967, the Corps completed its draft report on the Dos Rios Project. Upon review of this initial draft, the State of California indicated qualified support subject to additional study. The Chief of Engineers subsequently transmitted the final report for official state review on July 5, 1968.

The proposed Dos Rios Project became the subject of widespread interest and controversy. The Assembly Committee on Water and the Senate Committee on Water Resources held two public hearings and prepared reports

on the project. In May 1969, Governor Reagan expressed his concern about the project because it would flood Round Valley and displace the Indian community. He requested the Department of Water Resources to work with the Corps of Engineers to make further analyses of possible water development plans and alternatives within the Eel River watershed which would not involve flooding Round Valley.

This report has been prepared in response to the Governor's request.

NEED FOR WATER DEVELOPMENT SERVICES

Services which could be provided by water resources developments within the Eel River Basin may be considered under two categories: those which would benefit the area in and adjacent to the Eel River Basin and those which would benefit other areas in California.

The first category includes flood control, dependable water supplies for service areas in and near the basin, and recreational enhancement. Depending upon final formulation of the basin development plan ultimately selected, an enhancement of the fishery resources may also be provided.

The second category of services relates to the water supplies that can be developed on a dependable basis through coordination with existing features of the State Water Project and Central Valley Project for delivery to service areas in Central and Southern California.

These two categories of services are closely related, for it is through the economies of development scale involving the latter that the former may be possible. These services are discussed in the following paragraphs.

Flood Control

The most urgent present need within the Eel River Basin is for flood control. Many lands in the Eel River Basin are subjected to flooding on the average of once every three to four years. During the past 20 years, two major floods have occurred: one in December 1955 and a larger one in December 1964. The peak flow of the 1964 flood was 750,000 cubic feet per second at Scotia and 840,000 cubic feet per second at Fernbridge, near the mouth of the river. During the 1964 flood, 19 people lost their lives, countless others were left homeless, the economy of the basin was severely disrupted, and nearly $58 million in damages was incurred. The Northwestern Pacific Railroad was extensively damaged; 30 miles of track and roadbed adjacent to the Eel River were totally destroyed and three major railroad bridges were lost.

With dams, levees, floodplain management, and a flood warning system, this damage could have been greatly reduced. In a step to achieve the needed flood control, Congress authorized the Eel River Delta levees in October 1965. Subsequent planning studies on the levees by the Corps of Engineers have indicated that the most economical means of providing flood control in the Eel River Delta would be the levees in combination with upstream reservoir storage. Upstream reservoirs, when operated in conjunction with the delta levees, would have afforded protection against the 1964 flood.

However, according to the Corps of Engineers it is questionable whether it is practical to proceed with the levees without the development of upstream flood control storage. The North Coastal flood warning system installed by the Department in cooperation with the U. S. Weather Bureau and development of respect for floodplains will help, but until upstream flood storage is provided, the Eel River Basin is subject to destruction comparable to that which happened in 1964.

Recreation

The economy of the counties in and near the Eel River Basin is in large measure recreation-oriented. Reservoirs within the Eel River Basin could provide recreation opportunities which would complement those presently available. With proper development, not only would the economy of the local areas be enhanced, but the opportunity for recreationists from throughout the State would be expanded. Inland reservoir developments have proved to be especially attractive to residents of the San Francisco Bay area. These people, faced with cool summer climates, seek warm inland locations for their summer recreational pursuits. Popular areas include Lake Mendocino, Clear Lake, and Lake Berryessa.

A potential also appears to exist for enhancement of river recreation within the lower Eel watershed by means of controlled reservoir releases for fisheries and other purposes. Such releases would permit dependable summer-long recreational activities, such as swimming, fishing, canoeing, and rafting, on the main Eel River. These activities are possible now on a limited basis only, due to the normally low flow conditions and poor access.

Additional recreation opportunities could be provided by reservoirs outside the basin which are needed for development and transfer of Eel River water. The potential effect that Eel River water may have on the recreation and fishery resources of Clear Lake is still under investigation.

Water Demands in and Adjacent to the Eel River Area

Eel River reservoirs could provide a source of dependable water supplies to meet future municipal, industrial, and agricultural water demands for service areas in the counties of Mendocino, Lake, Sonoma, Napa, and Marin. It is anticipated that there will be a demand in those counties for additional water supplies in the order of 40,000 acre-feet annually by the year 1990 and increasing to about 200,000 acre-feet annually by the year 2015. This demand buildup is based on the assumption that the price of agricultural water at the farm headgate would be in the magnitude of $20 per acre-foot. Information on local water demands is developed in the Department's Nine-County Investigation, which is a cooperative study with the counties concerned. It is in partial fulfillment of the legislative requests contained in Senate Concurrent Resolution 76 of the 1968 Session, which asked the Department to make further studies of the Eel River routing.

Water Demands of the State Water Project

Present contracts for water service under the State Water Project call for deliveries at full entitlement levels of 4,230,000 acre-feet annually. This demand will increase from 322,000 acre-feet annually in 1970 to 2,243,000 acre-feet in 1980 to essentially the full entitlement level by 1990.

The dependable water supply capability of the initial conservation facilities of the State Water Project, i.e., Oroville Reservoir, San Luis Reservoir, and the delta facilities, is estimated to be about 3,300,000 acre-feet annually by about the year 1990. The additional dependable supply which must be developed is therefore approximately 900,000 acre-feet per year by 1990. The need for the additional water begins in 1986.

This amount of additional supply will not be needed every year of project operation. It is the average annual additional quantity which would be required to meet existing contracts in the event of a critically dry period similar to that which occurred from 1928 through 1934. This same period governs the dependable yield capability of most conservation facilities in Northern California.

In addition to the 900,000 acre-feet per year of additional supply which must be provided to meet present contract commitments, it is envisioned that water service from the State Water Project will be increased in the future beyond present contractual entitlements. Part of this increase will result from supplemental service which will be required by present contractors and part through service to new contractors. While requirements will continue to increase beyond 1990, the rate of increase may not be as rapid as prior to that time. Continuing investigations are needed to determine the appropriate source of supply to meet these needs.

SUMMARY OF PRINCIPAL ALTERNATIVES

Sixteen alternative projects were initially selected for consideration in this study. The various damsites considered are shown on Figure 1. Analyses of these alternatives revealed six project configurations which show the greatest potential; these have been identified as the principal alternatives.

The physical features involved and the cost and accomplishments of these principal alternatives are shown in Table 1. For comparative purposes, the table also includes data on the Corps of Engineers' proposed Dos Rios Project, coupled with both an eastern and a southern diversion route, and an independent English Ridge Project which could supply water for local use in the event an easterly diversion route is selected. The first cost of the Corps of Engineers' basic Dos Rios Project in Table 1 has been increased to reflect the revised cost of the Grindstone Tunnel.

The six principal alternatives shown in Table 1 are subject to modification with further study, but they do illustrate the general types of development which could meet the water supply objectives without flooding Round Valley. Alternatives 1 and 4 involve a small Dos Rios Reservoir which would not inundate Round Valley, combined with both an eastern and a southern diversion routing. Alternatives 2 and 5 are similar, but are based on a medium-sized Dos Rios Reservoir with a dam at the Mill Creek outlet of Round Valley to exclude the reservoir waters from the valley, and a drainage tunnel to remove the natural runoff from the valley. Alternatives 3 and 6 are eastern and southern routing plans from a large Yellow Jacket Reservoir on the lower Eel River.

A dam of some size at the Dos Rios site is central to any project which is to develop a water supply from the Eel River Basin comparable to that which could be developed by the Corps of Engineers' proposed Dos Rios Project. Larger amounts of water could be developed from the lower Eel River, but the most economical export routes out of the lower basin would also involve a dam at the Dos Rios site.

In the final formulation of any of these projects, the first cost and total average annual cost would be allocated among the purposes served, which may include water supply, flood control, recreation, and possibly fish and wildlife enhancement. Benefit evaluations and cost allocations were beyond the scope of this study.

Table 2 summarizes the environmental effects of the principal alternatives. It shows acres of land inundated, reservoir shoreline created, number of people displaced, miles of stream channel inundated, miles of stream channel with increased summer flows, and fish runs affected.

Table 3, on page 32, presents information on the 10 secondary alternatives and explains why they were not included among the principal ones.

- There are alternatives to the Corps of Engineers' proposed Dos Rios Project on the Eel River that do not flood Round Valley.

- Of the original 16 alternative projects considered, six principal alternatives have been identified. They involve three basic plans of Eel River development, each of which could be coupled with either an easterly diversion routing with holdover storage on Stony Creek in Glenn County, or a southerly routing through Clear Lake with holdover storage on Cache Creek. These three basic plans are: (a) a small Dos Rios Reservoir which would not flood Round Valley, (b) a medium-sized Dos Rios Reservoir with auxiliary features to protect Round Valley, and (c) a Yellow Jacket Reservoir on the lower Eel River.

- Each of the principal alternatives would provide at least 900,000 acre-feet of annual water supply at the Sacramento-San Joaquin Delta. They would differ somewhat in flood control, recreation potential, local water yield, and environmental effects.

- Alternatives involving a southerly diversion routing through Clear Lake include an English Ridge Reservoir and would provide water service to local areas.

- All alternatives which would provide accomplishments essentially equivalent to those provided by the Corps of Engineers' proposed Dos Rios Project have greater capital cost than the Corps' proposal.

- Alternatives which would not provide flood control storage would probably preclude federal financing and construction and state participation under the Water Supply Act of 1958.

- Feasibility studies of all aspects of project development are needed prior to the implementation of any of the alternatives.

TABLE 1
SUMMARY OF ACCOMPLISHMENTS AND COST
PRINCIPAL ALTERNATIVES

	PROJECT	PHYSICAL FEATURES			ACCOMPLISHMENTS			COSTS	
		RESERVOIRS Capacity in Million Acre-Feet		TUNNELS	WATER YIELD Acre-Feet Per Year [a]	FLOOD PEAK REDUCTION Cubic Feet Per Second [b]	RECREATION AT MAXIMUM DEVELOPMENT Recreation Days Per Year	FIRST COST Millions of Dollars [c]	TOTAL AVERAGE ANNUAL COST Millions of Dollars [d]
Eastern Diversion Route	USCE Dos Rios Project -- Eastern Route	Dos Rios	7.60	Grindstone	900,000	210,000	2,000,000	462	32.4
	Alternative 1	Dos Rios Rancheria	0.54 5.00	Grindstone	900,000	10,000	980,000	471	30.9
	Alternative 2	Dos Rios Rancheria	1.65 4.78	Grindstone Round Valley Drain	900,000	200,000	1,000,000	525	34.9
	Alternative 3	Yellow Jacket Dos Rios Rancheria	8.68 0.44 4.20	Yellow Jacket-Round Valley Grindstone	1,470,000	260,000 [e]	3,080,000	988	68.5
	Independent English Ridge Project [f]	English Ridge	1.80	Garrett	200,000	90,000	2,200,000	191	10.3
Southern Diversion Route	USCE Dos Rios Project -- Southern Route	Dos Rios Willis Ridge English Ridge	7.60 0.08 1.80	Dos Rios-Willis Ridge Garrett	1,100,000	260,000	4,600,000	629	44.9
	Alternative 4	Dos Rios Willis Ridge English Ridge Blue Ridge Bear Valley	0.54 0.08 1.80 2.32 2.30	Dos Rios-Willis Ridge Garrett	1,100,000	100,000	4,400,000	686	45.9
	Alternative 5	Dos Rios Willis Ridge English Ridge Blue Ridge Bear Valley	1.65 0.08 1.80 2.32 2.30	Dos Rios-Willis Ridge Garrett Round Valley Drain	1,100,000	260,000	4,420,000	815	54.4
	Alternative 6	Yellow Jacket Dos Rios Willis Ridge English Ridge Blue Ridge	10.38 0.44 0.08 1.80 2.32	Yellow Jacket-Round Valley Dos Rios-Willis Ridge Garrett	1,690,000	260,000 [e]	6,000,000	1,240	86.6

[a] 900,000 acre-feet referenced to Sacramento-San Joaquin Delta; remainder on a schedule suitable for local use.

[b] Reduction of December 1964 peak flow of 750,000 cubic feet per second at Scotia which would have occurred with projects operating in conjunction with the proposed Eel Delta levees. A reduction of 260,000 cubic feet per second would have limited flows in the Delta to the design capacity of the proposed levees.

[c] First cost represents actual dollar outlay for design and construction of all project features, including rights-of-way, relocations, fish and wildlife preservation facilities, initial recreation development, engineering, and contingencies.

[d] Includes all costs for operation, maintenance, replacement, pumping power, future recreation development, and amortization of capital costs.

[e] Yellow Jacket Reservoir could be operated to effect greater reductions, but this reduction is adequate to limit downstream flows to the proposed levee design capacity.

[f] Could be added to projects involving eastern diversions to provide local water supply equivalent to that provided by projects involving southern diversions.

TABLE 2
SUMMARY OF ENVIRONMENTAL EFFECTS
PRINCIPAL ALTERNATIVES

	PROJECT	RESERVOIRS Capacity in Million Acre-Feet		LAND INUNDATED In Acres	RESERVOIR SHORELINE CREATED In Miles	PEOPLE DISPLACED	MILES OF MAIN STREAM CHANNEL		AVERAGE ANNUAL ANADROMOUS FISH RUNS AFFECTED	
							Inundated[a]	With Increased Summer Flow	Salmon	Steelhead
Eastern Diversion Route	USCE Dos Rios Project -- Eastern Route	Dos Rios	7.60	40,000	240	1,500	36	118	13,000	23,000
	Alternative 1	Dos Rios	0.54	4,300	70	10	25	118	13,000	23,000
		Rancheria	5.00	35,200	130	330	23	---	---	---
	Alternative 2	Dos Rios	1.65	10,400	80	50	31	118	13,000	23,000
		Rancheria	4.78	34,500	130	330	23	---	---	---
	Alternative 3	Yellow Jacket	8.68	33,500	210	420	56	59	42,000	62,000
		Dos Rios	0.44	3,800	70	10	24	---	[b]	[b]
		Rancheria	4.20	31,700	130	330	23	---	---	---
	Independent English Ridge Project	English Ridge	1.80	11,800	170	200	28	133	10,000	14,000
Southern Diversion Route	USCE Dos Rios Project --- Southern Route	Dos Rios	7.60	40,000	240	1,500	36	118	13,000	23,000
		Willis Ridge	0.08	1,000	20	10	14	7	12,000	15,000
		English Ridge	1.80	11,800	170	200	28	---	[b]	[b]
	Alternative 4	Dos Rios	0.54	4,300	70	10	25	118	13,000	23,000
		Willis Ridge	0.08	1,000	20	10	14	7	12,000	15,000
		English Ridge	1.80	11,800	170	200	28	---	[b]	[b]
		Blue Ridge	2.32	14,200	190	60	34	---	---	---
		Bear Valley	2.30	14,200	50	20	--	---	---	---
	Alternative 5	Dos Rios	1.65	10,400	80	50	31	118	13,000	23,000
		Willis Ridge	0.08	1,000	20	10	14	7	12,000	15,000
		English Ridge	1.80	11,800	170	200	28	---	[b]	[b]
		Blue Ridge	2.32	14,200	190	60	34	---	---	---
		Bear Valley	2.30	14,200	50	20	--	---	---	---
	Alternative 6	Yellow Jacket	10.38	37,500	220	420	61	59	42,000	62,000
		Dos Rios	0.44	3,800	70	10	24	---	[b]	[b]
		Willis Ridge	0.08	1,000	20	10	14	---	[b]	[b]
		English Ridge	1.80	11,800	170	200	28	---	[b]	[b]
		Blue Ridge	2.32	14,200	190	60	34	---	---	---

a/ Includes main Eel River, Middle Fork Eel River, North Fork Eel River, Cache Creek, North Fork Cache Creek, Stony Creek, and Grindstone Creek.
b/ Fish runs blocked at dam downstream.

DISCUSSION OF PRINCIPAL ALTERNATIVES

The six principal alternatives involve three basic plans of Eel River development, each of which could be coupled with either an easterly diversion routing with holdover storage at Rancheria Reservoir on Stony Creek or a southerly routing through Clear Lake with holdover storage at Blue Ridge and Bear Valley Reservoirs in the Cache Creek Basin.

This section discusses the water supply, flood control, and recreation potentials of the principal alternatives; the three basic plans of Eel River development; English Ridge Reservoir; and Sacramento Valley holdover storage.

Water Supply

Each Eel River alternative would provide a yield of at least 900,000 acre-feet per year, referenced to the Sacramento-San Joaquin Delta. Sizable holdover storage in the Sacramento Valley, usually in excess of 4 million acre-feet, would be required in each case. The alternatives involving Yellow Jacket Reservoir on the lower Eel River would provide a water supply, referenced to the Delta, considerably greater than 900,000 acre-feet per year.

Local demands in and adjacent to the Eel River Basin are expected to reach about 200,000 acre-feet annually by the year 2015. These demands could be met by the English Ridge Project, either as an independent project in connection with an eastern diversion route or as an integral feature of an alternative involving a southern diversion route.

Flood Control

The greatest degree of flood protection in the Eel River Basin would be achieved by the alternatives involving Yellow Jacket Reservoir. The medium-sized Dos Rios Reservoir would contain the same flood storage reservation as the Corps of Engineers' proposed Dos Rios Reservoir and would achieve nearly the same degree of flood protection. The small Dos Rios Reservoir would not contain a specific flood storage reservation and would provide essentially no flood control in the Eel River Basin. A limited amount of flood control would be achieved by the English Ridge Project.

Recreation

The recreation potential of the alternative plans involving a small Dos Rios Reservoir is about the same as that of the alternatives

involving the medium-sized reservoir. Depending on the routing, the recreation potential ranges from one-half to about the same as that for plans involving the Corps' proposed Dos Rios Reservoir. The recreation potential of the southerly diversion route alternatives for a given basic Eel River plan is considerably greater than that of the easterly route alternatives involving the same basic plan. The recreation potential of either Yellow Jacket Reservoir or English Ridge Reservoir is essentially the same as that of the Corps' proposed Dos Rios Reservoir.

Small Dos Rios Reservoir, Alternatives 1 and 4

The absence of flood control storage in the small Dos Rios Reservoir would probably preclude federal financing and construction and state participation under the Water Supply Act of 1958. Financing and construction would be entirely the responsibility of the State.

The small Dos Rios Reservoir would be located in a narrow canyon and would have large water surface fluctuations. Developable land would be limited and recreation potential would be poor. In addition, there are potentially serious problems with sedimentation and landslide debris in the reservoir; if more material entered the reservoir than is anticipated, the project cost and feasibility could be seriously affected.

The small reservoir would affect the same anadromous fish runs as the large Dos Rios Project and the fishery preservation problems would be similar. However, the small reservoir would naturally spill more than a large one, and the large spills could possibly remove sedimentation by scouring the main river channel below the dam, thus providing a somewhat better downstream fishery habitat. The small reservoir would have a relatively minor impact on wildlife in the area and the preservation problems would be less difficult than with the larger reservoirs.

It would be essential to thoroughly investigate the problems associated with the small Dos Rios Reservoir before making a commitment for its implementation.

Medium-Sized Dos Rios Reservoir, Alternatives 2 and 5

The medium-sized Dos Rios Reservoir would involve a dam at the Mill Creek outlet of Round Valley to exclude the reservoir waters from the valley, and a drainage tunnel to remove the natural runoff from the valley.

The medium-sized reservoir would contain the same primary flood storage reservation as the Corps of Engineers' proposed Dos Rios Reservoir. However, the flood peak reduction would not be as great with the medium-sized reservoir since the Mill Creek flows would pass uncontrolled through the Round Valley drain tunnel to the river below Dos Rios Dam.

The medium-sized Dos Rios Reservoir could be financed and constructed by the Federal Government and the State could participate under the Water Supply Act of 1958.

The medium-sized reservoir is subject to fewer problems with landslides and sedimentation than a small reservoir, but still more than the large Dos Rios Reservoir. The medium-sized reservoir would be confined to the canyon areas with little developable land and recreation potential would be poor. The water surface fluctuations would be greater than those of the large reservoir but less than those of the small reservoir. The reservoir would affect the same anadromous fish runs as the large Dos Rios Reservoir and the fishery preservation problems would be similar. The medium-sized reservoir would have a moderate impact on wildlife.

Yellow Jacket Reservoir, Alternatives 3 and 6

Yellow Jacket Reservoir on the lower Eel River would provide excellent flood control. The project could be financed and constructed by the Federal Government and the State could participate under the Water Supply Act of 1958.

The Reservoir would block passage for nearly the entire anadromous fish run of the main Eel River. Fish and wildlife preservation problems would be substantial. The reservoir would be large enough to minimize any potential operational difficulties from sediment and landslide inflows into the reservoir.

The project would more fully develop the water resources of the Eel River. However, the amount of water which would be developed in one block is more than would be required in the near future and repayment of costs could be a problem.

The Yellow Jacket Project requires the construction of upstream features for conveyance of its developed water supply. Construction of the total project, including associated conveyance facilities and holdover storage, would cost about $1 billion, including the cost of relocation of 93 miles of the Northwestern Pacific Railroad.

English Ridge Reservoir

All plans involving a southerly diversion routing through Clear Lake include an English Ridge Reservoir, with 1.8 million acre-feet of storage capacity. This is the size recommended by the U. S. Bureau of Reclamation in its feasibility report on the project.

Sacramento Valley Holdover Storage

The development of Eel River water to meet the water demand pattern in the Sacramento-San Joaquin Delta can, in most cases, be economically accomplished by the incorporation of large holdover storage

in the Sacramento Valley. Besides being integral features of schemes for developing Eel River water, these Sacramento Valley Reservoirs would achieve certain benefits of their own, including conservation of local runoff, flood control, and recreation opportunities.

Alternatives 3 and 6, involving the large Yellow Jacket Reservoir, could be formulated without holdover storage in the Sacramento Valley. However, the Sacramento Valley reservoirs would allow substantial savings in costs of conveyance facilities, as well as provide additional yield. Therefore, these alternatives have been formulated with holdover storage reservoirs.

Eastern Diversion Route

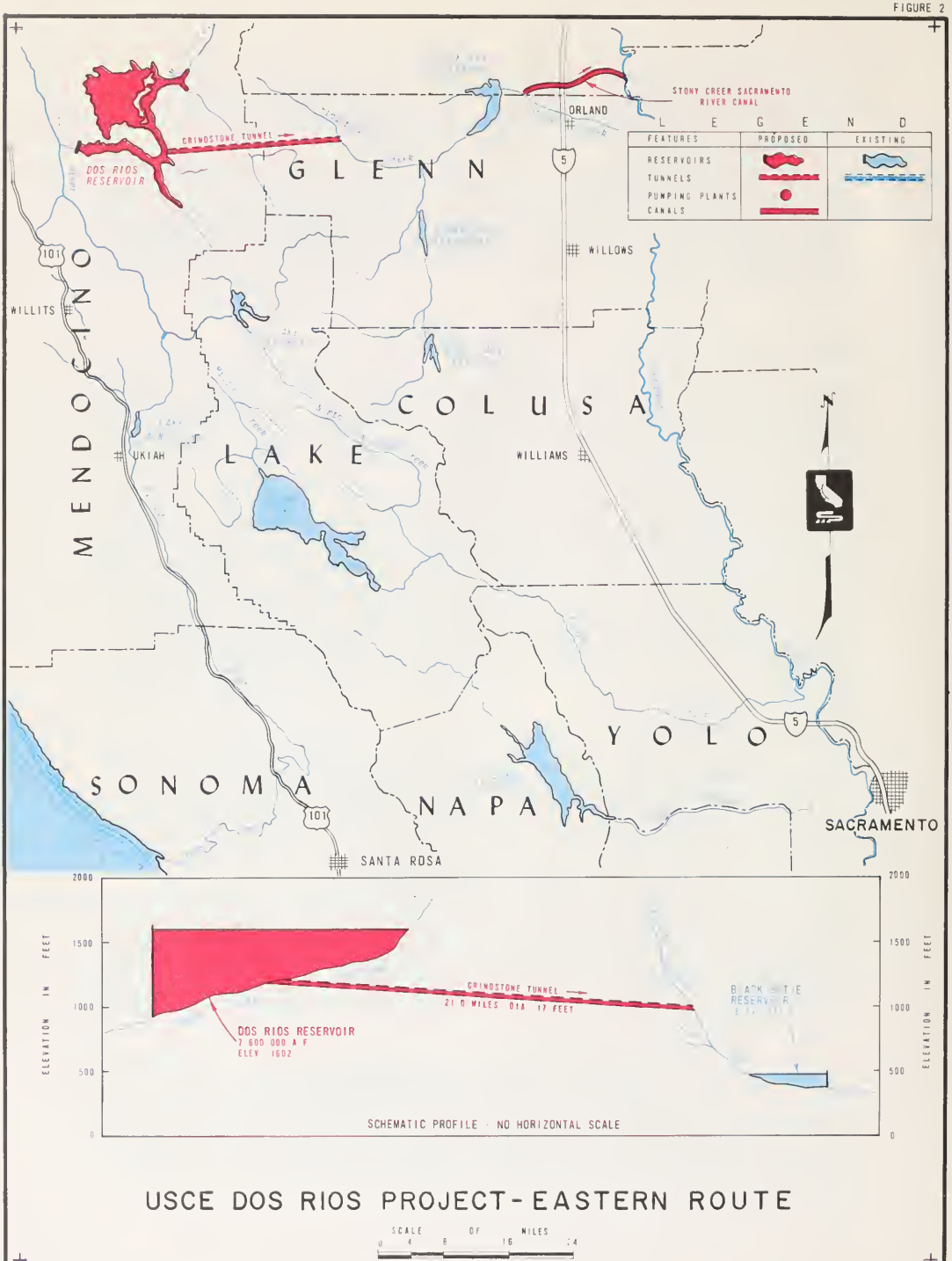
A Rancheria Reservoir on Stony Creek is required for each principal alternative involving an eastern conveyance route. The reservoir size would vary from about 4 to 5 million acre-feet, depending on the operational capabilities of the Eel River features. For a given water supply yield, the greater the storage in Eel River reservoirs, the less is required on the Sacramento Valley side.

Rancheria Reservoir, studied in previous investigations, would cover about 35,000 acres of rolling foothill land in western Glenn County. The reservoir would require relocation of the residents of the town of Elk Creek and the Grindstone Indian Rancheria and inundate the existing Stony Gorge Reservoir. Coordinated operation of Rancheria Reservoir could help stabilize the water surfaces of Black Butte and East Park Reservoirs and thereby improve the recreation opportunities at these projects.

Southern Diversion Route

Required holdover storage on the southern routing can be provided in the Cache Creek Basin. Previous studies identified three possible alternative damsites on Cache Creek: Wilson Valley, Kennedy Flats, and Blue Ridge. The Blue Ridge site has been selected for purposes of this study since it has the greatest storage potential. This study has also identified another possible storage site on Bear Creek, a tributary to Cache Creek. A dam at the Bear Creek site would create a Bear Valley Reservoir which would operate in conjunction with Blue Ridge Reservoir. Water would be pumped from Blue Ridge Reservoir to Bear Valley Reservoir. This study indicates that the required holdover storage on Cache Creek can most economically be provided by a combination of Blue Ridge and Bear Valley Reservoirs. However, more study would be required to formulate the optimum combination.

In those southern routing plans involving small and medium-sized Dos Rios Reservoirs, 4.6 million acre-feet of holdover storage would be provided on Cache Creek, one-half in Blue Ridge Reservoir and one-half in Bear Valley Reservoir. For the plan involving Yellow Jacket Reservoir, 2.3 million acre-feet of storage would be provided at Blue Ridge Reservoir.



USCE DOS RIOS PROJECT - EASTERN ROUTE

PROJECT DESCRIPTIONS

The following sections present capsule descriptions and plans and profiles of the principal alternatives and the two developments involving the Corps of Engineers' Dos Rios Reservoir.

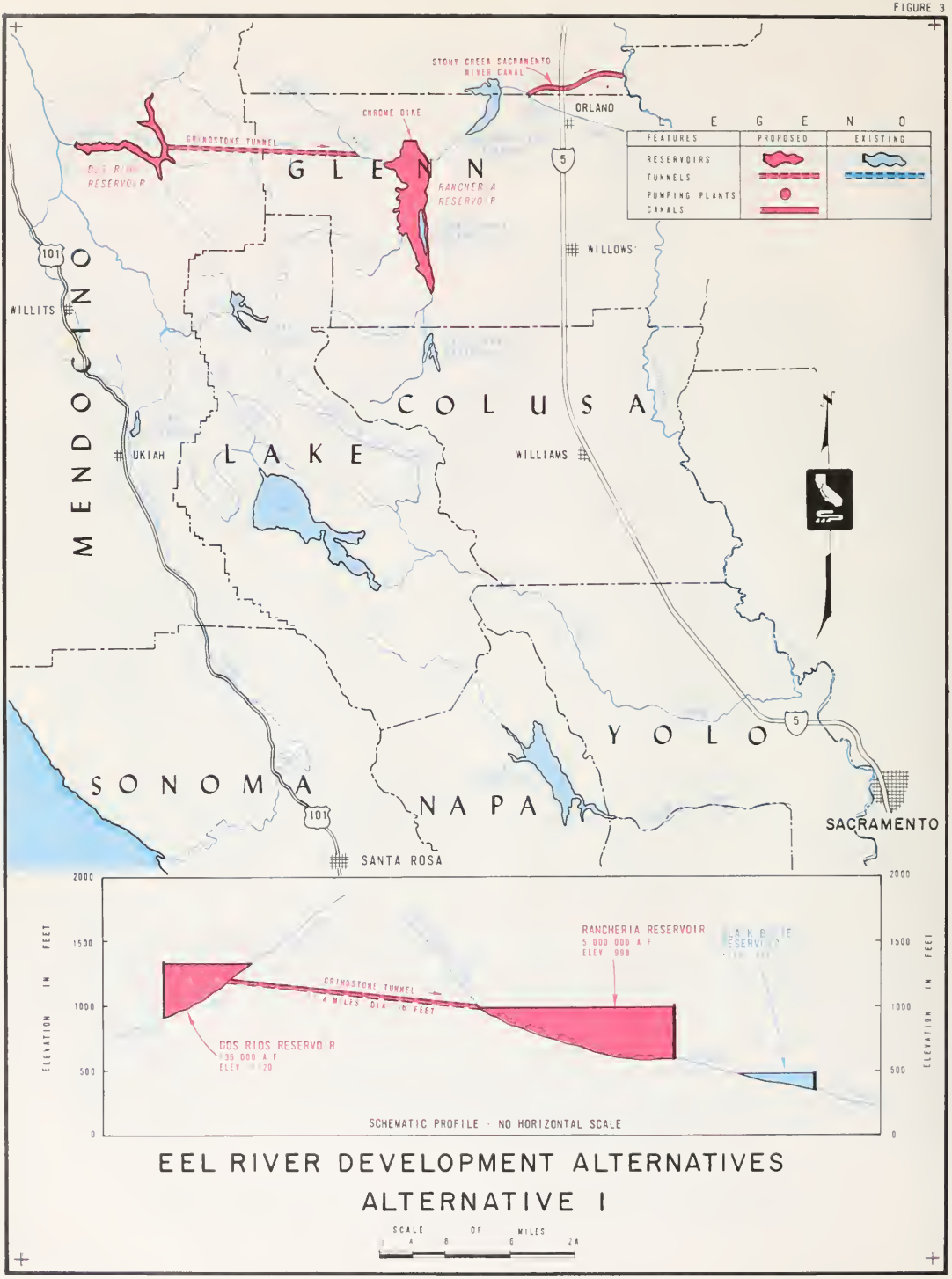
USCE Dos Rios Project -- Eastern Route

This is the basic Dos Rios Project as proposed by the Corps of Engineers in its "Interim Report on Water Resources Development for Middle Fork Eel River", April 1968. The project would consist of a large Dos Rios Reservoir, a 730-foot-high dam, and a 21-mile Grindstone Tunnel to divert water to the Sacramento River via Stony Creek. The project first costs shown in Table 1 were derived from the Corps' report by indexing costs to July 1969 price levels and adding the cost of the Stony Creek-Sacramento River Canal ($8 million). The estimated cost of the Grindstone Tunnel was also increased about 12 percent to reflect the comments of Bechtel, Incorporated, an engineering organization retained by the Department of Water Resources to review project costs. This tunnel cost increase may result in some modifications in sizing and operation of some features during the design studies.

This development would yield 900,000 acre-feet per year, referenced to the Sacramento-San Joaquin Delta. With its specific flood reservation of 600,000 acre-feet, the large Dos Rios Reservoir would have reduced the December 1964 flood peak of 750,000 cubic feet per second at Scotia by 210,000 cubic feet per second. The December 1964 flood peak of 840,000 cubic feet per second in the Eel River Delta at Fernbridge would have been reduced to 650,000 cubic feet per second. The maximum recreation potential of the reservoir is estimated as 2,000,000 recreation-days per year. As formulated, the Corps' project would also provide a minor amount of hydroelectric power.

The large Dos Rios Reservoir would inundate a total of about 40,000 acres, including the 18,000-acre Round Valley. It would require relocation of approximately 1,500 people, including many of the 350 Indians of the Round Valley Reservation. The reservoir would have a substantial effect on wildlife resources, particularly deer within Round Valley. It would inundate about 36 miles of the Middle Fork Eel River channel, increase summer flows in 118 miles of main stream channel, and create 240 miles of reservoir shoreline.

This project would block an estimated average annual run of 36,000 salmon and steelhead from their natural spawning grounds. However, the large Dos Rios Reservoir would facilitate control of temperature and turbidity of water used to operate a fish hatchery and for downstream fishery preservation releases. The large reservoir would also allow good control of the turbidity and nutrient levels of waters diverted to the Sacramento River. Finally, the large reservoir, with its 2,000,000 acre-feet of inactive storage capacity, would be able to contain anticipated sediment and landslide deposition without difficulty for several centuries. About 1,500,000 acre-feet of this inactive storage capacity is included for recreation and aesthetic purposes to prevent exposure of mud flats and to provide hydraulic head for the Grindstone Tunnel.



EEL RIVER DEVELOPMENT ALTERNATIVES

ALTERNATIVE I

SCALE OF MILES

Alternative 1: Small Dos Rios -- Eastern Route

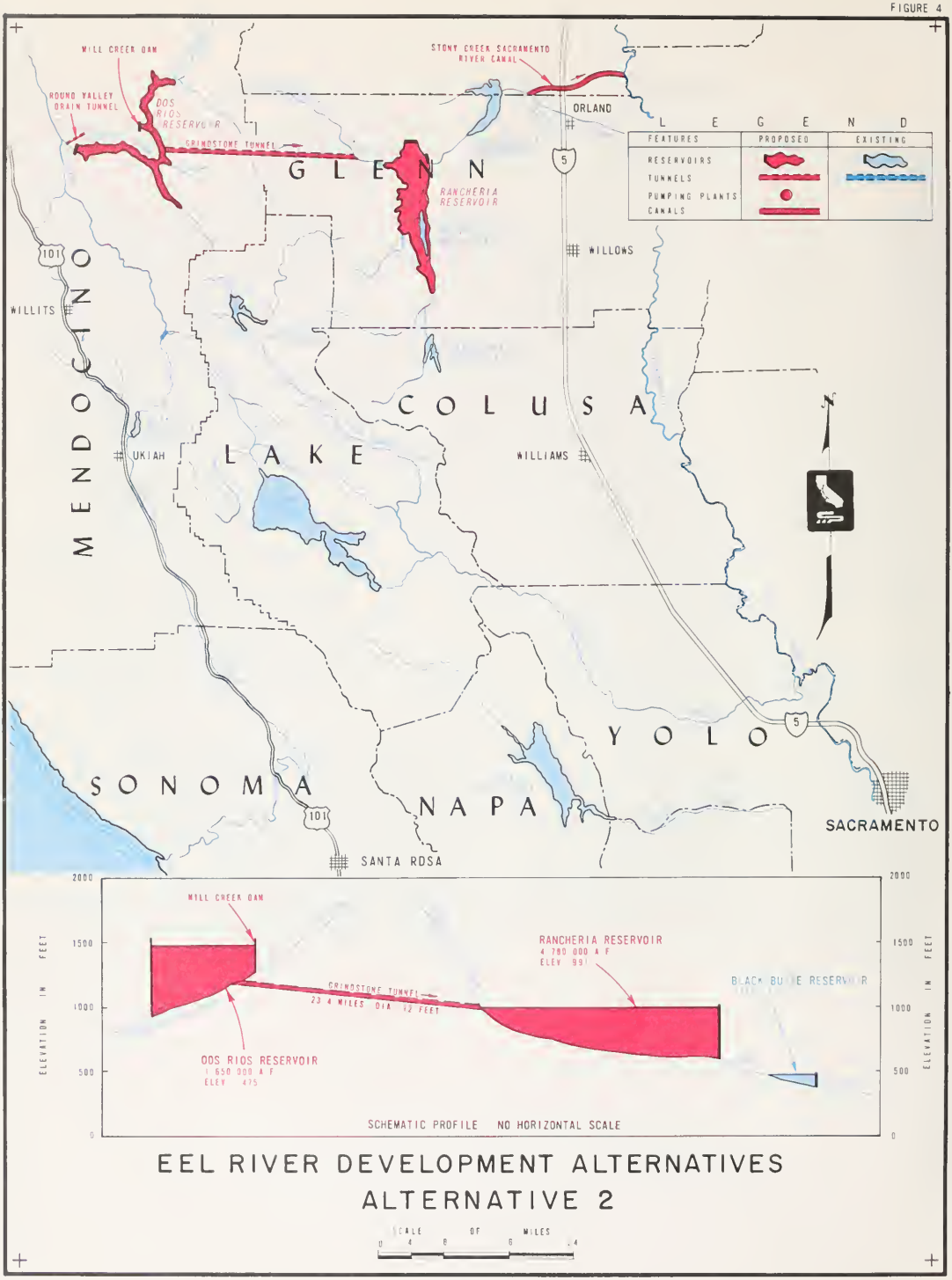
The major features of Alternative 1 would be a small Dos Rios Reservoir formed by a 420-foot-high dam, a 23.4-mile Grindstone Tunnel, and a 428-foot-high Rancheria Dam on Stony Creek; pumping would not be required.

This system would yield 900,000 acre-feet per year, referenced to the Sacramento-San Joaquin Delta. The limited amount of storage in the small Dos Rios Reservoir would preclude any specific flood reservation, and the project would have only an incidental effect on Eel River floods. The small Dos Rios Reservoir would provide for a maximum annual recreation use of 300,000 recreation-days and Rancheria Reservoir would provide for a maximum annual use of 685,000 recreation-days.

In order to provide sufficient capacity for landslide debris and sediment deposition and for water development, Dos Rios Reservoir must encroach on Round Valley. To minimize the encroachment, a 536,000 acre-foot reservoir was chosen to illustrate this alternative. This reservoir would inundate about 700 acres in the lower (southeastern) corner of Round Valley and would be only marginally capable of operation over the 100-year period due to probable encroachment into the active storage space by sediment and landslide debris. Extensive additional studies would be required to establish the volume of material which would be trapped in the small Dos Rios Reservoir; any underestimation of the amount could lead to severe operational problems. Special measures may be required to stabilize the Salmon Creek landslide located in a narrow portion of the canyon 10 miles upstream from Dos Rios Dam. The costs in Table 1 include an allowance of $10,000,000 for care of the Salmon Creek landslide; extensive field investigations would be needed to determine the specific remedial measures required, and higher costs could be incurred.

Dos Rios Reservoir would necessitate preservation measures for runs of salmon and steelhead averaging 36,000 fish per year. The small reservoir would permit little control over temperature and quality of downstream fishery preservation releases and diversions to Rancheria Reservoir.

The small Dos Rios Reservoir would inundate about 4,300 acres of canyon lands and about 25 miles of the Middle Fork Eel River channel, increase summer flows in 118 miles of main stream channel, and create 70 miles of reservoir shoreline. The reservoir would displace fewer than 10 permanent residents. It would cause minimal interference with wildlife resources. On the other hand, Rancheria Reservoir would cover about 35,200 acres of rolling foothill lands in western Glenn County and create 130 miles of reservoir shoreline. The reservoir would require relocation of approximately 330 persons, including those in the town of Elk Creek and some 25 Indians of the 80-acre Grindstone Rancheria. Rancheria Reservoir would have a relatively minor effect on wildlife and only limited preservation measures would be required.



EEL RIVER DEVELOPMENT ALTERNATIVES
ALTERNATIVE 2

SCALE OF MILES
0 4 8 16

Alternative 2: Medium-Sized Dos Rios -- Eastern Route

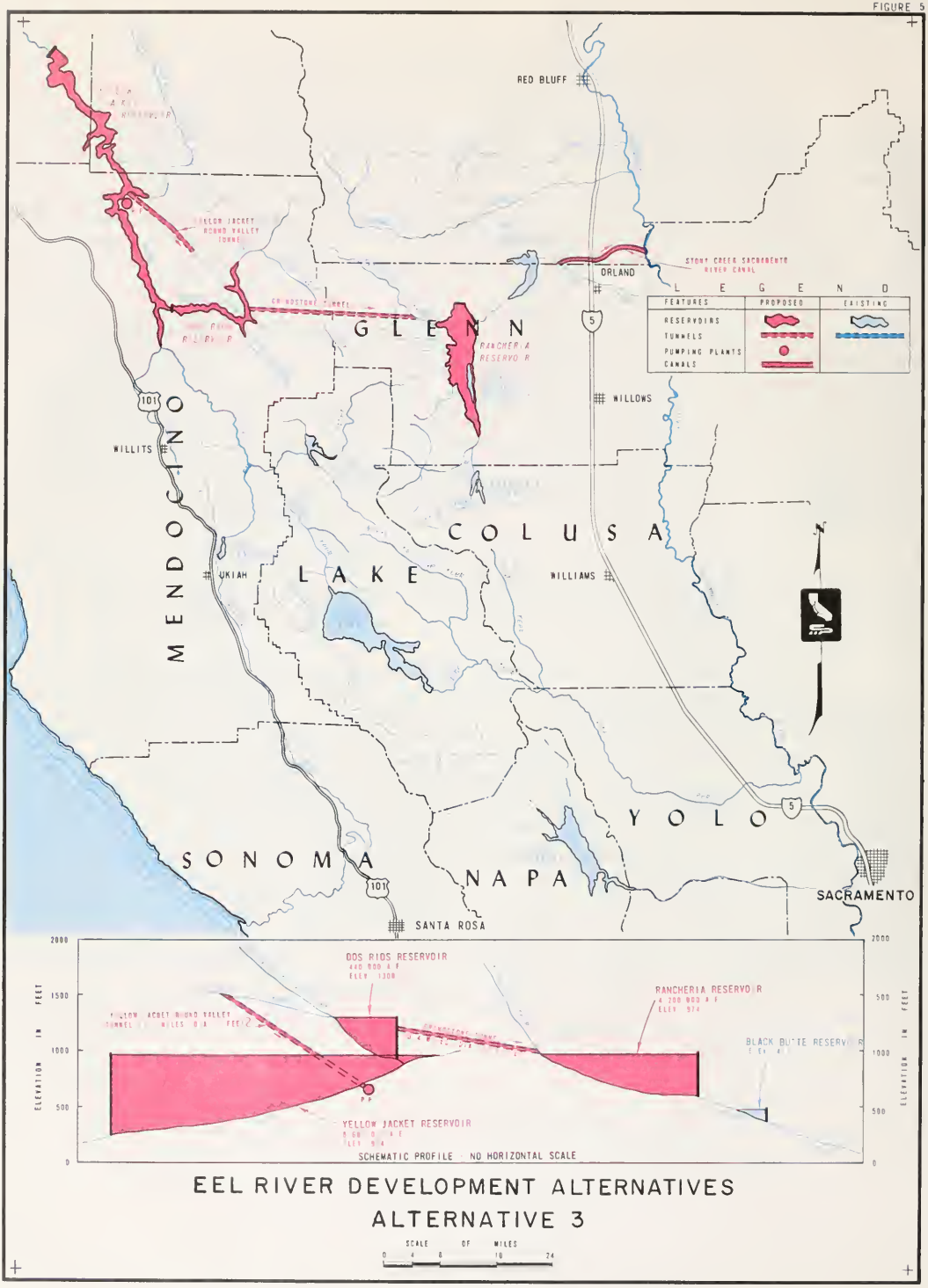
The central features of Alternative 2 would be a 605-foot-high Dos Rios Dam and a 250-foot-high dam on Mill Creek at the southeast corner of Round Valley. Mill Creek Dam would prevent the waters of Dos Rios Reservoir from entering the valley, but would also block off the natural drainage outlet of the valley. A 17-foot-diameter tunnel, 4.8 miles long, would be constructed to carry the runoff from the valley to a point in the Eel River downstream from Dos Rios Dam. Water conserved in the 1,650,000-acre-foot Dos Rios Reservoir would be released through the Grindstone Tunnel to Rancheria Reservoir, formed by a 421-foot-high dam on Stony Creek.

This alternative would produce 900,000 acre-feet of yield annually, reference to the Sacramento-San Joaquin Delta. The medium Dos Rios Reservoir would include 600,000 acre-feet of specific flood reservation, the same as the Corps' proposed reservoir. This would have reduced the 1964 flood peak at Fernbridge from 840,000 to 660,000 cubic feet per second and at Scotia from 750,000 to 550,000 cubic feet per second (these reductions would be slightly smaller than those accomplished by the Corps' proposal because of the discharge from the Round Valley Drain Tunnel downstream from the dam). The recreation potential of Dos Rios Reservoir with Round Valley protected would be limited; maximum annual use is estimated as 320,000 recreation-days. The estimated maximum annual use of Rancheria Reservoir is 685,000 recreation-days.

The drainage tunnel for Round Valley would not be able to carry the maximum instantaneous runoff from the valley; some temporary ponding would result at the tunnel intake during major storms. Flowage easements would be acquired for land affected, or, at much greater cost, the tunnel could be made sufficiently large to avoid ponding in the valley.

The medium-sized Dos Rios Reservoir would include 350,000 acre-feet of inactive storage capacity, which would be adequate to store the estimated sediment deposition and landslide debris for about 100 years. The 700,000 acre-feet of conservation storage would provide a safety factor against an underestimation of debris volume, a factor which would not exist with the small Dos Rios Reservoir.

The medium-sized Dos Rios Reservoir would inundate about 10,400 acres of canyon lands, flood about 31 miles of the Middle Fork Eel River channel, increase summer flows in 118 miles of main stream channel, and create 80 miles of reservoir shoreline. The reservoir would have far less effect on wildlife resources than a reservoir which included Round Valley. It would displace about 50 people. Rancheria Reservoir would cover about 34,500 acres in western Glenn County and create 130 miles of reservoir shoreline. It would require relocation of approximately 330 persons, including those in the town of Elk Creek and some 25 Indians of the 80-acre Grindstone Rancheria. Rancheria Reservoir would have a relatively minor effect on wildlife and only limited preservation measures would be required.



EEL RIVER DEVELOPMENT ALTERNATIVES

ALTERNATIVE 3

SCALE OF MILES

0 4 8 16 24

Alternative 3: Yellow Jacket -- Eastern Route

The major feature of Alternative 3 would be a 734-foot-high Yellow Jacket Dam on the lower Eel River, creating an 8,680,000-acre-foot reservoir. An underground pumping plant near the mouth of the North Fork Eel River would lift the reservoir water about 800 feet through an 11.1-mile tunnel to Mill Creek, above the northwest corner of Round Valley. Mill Creek would carry the diversions through the valley to a reservoir formed by a 400-foot-high Dos Rios Dam. From there, releases would be made through the Grindstone Tunnel to a 4,200,000-acre-foot Rancheria Reservoir, created by a 404-foot-high dam on Stony Creek.

Because this system involves the addition of Yellow Jacket Reservoir to the low Dos Rios-Rancheria Project presented as Alternative 1, it would produce considerably more yield than Alternative 1. With the assumption that an independent English Ridge Project would be in operation to divert 200,000 acre-feet of water annually out of the upper basin, this alternative would yield 900,000 acre-feet per year, referenced to the Sacramento-San Joaquin Delta, plus an additional 570,000 acre-feet annually on a firm schedule suitable for use in an unspecified service area. The illustrated Yellow Jacket Reservoir would include a specific flood reservation of 900,000 acre-feet; when operated with the proposed Eel Delta levees, the reservoir would provide protection from floods much larger than that which occurred in December 1964. When operated in conjunction with the Eel Delta levees, this project would have reduced the December 1964 flood peak at Scotia from 750,000 to 490,000 cubic feet per second.

The maximum recreation potential of Yellow Jacket Reservoir is estimated as 2,100,000 recreation-days per year. Maximum use at the small Dos Rios Reservoir would reach 300,000 recreation-days per year and at Rancheria Reservoir, 685,000 recreation-days per year.

Yellow Jacket Reservoir would inundate about 33,500 acres along the Eel River Canyon and, together with Dos Rios Reservoir, would cover about 80 miles of the channels of the main river and its forks, increase summer flows in 59 miles of main stream channel, create 280 miles of reservoir shoreline, and necessitate relocation of about 93 miles of the Northwestern Pacific Railroad from Willits to the mouth of the South Fork Eel River. The reservoir would be large enough to minimize any potential operation difficulties from sediment deposition or landslide debris. It would displace about 420 permanent residents.

About half the salmon and steelhead spawning in the Eel River Basin takes place upstream from Yellow Jacket Dam site. The runs at the damsite are estimated to average 104,000 fish per year, about three times the size of the runs at Dos Rios Dam site. Major preservation measures would be necessary to prevent serious fishery losses, and large downstream releases would be needed for fishery maintenance. Substantial efforts would also be required for wildlife preservation.

The Dos Rios Reservoir included in this alternative is illustrated at a size which would not encroach upon Round Valley. It would have a very limited active storage capacity but would be subject to the same problems as the low reservoir shown in Alternatives 1 and 4.

The Rancheria Reservoir used in this alternative would be similar to the ones shown for Alternatives 1 and 2, although it would be slightly smaller, requiring inundation of 31,700 acres. The reservoir would displace a total population of 330 persons, including those in the town of Elk Creek and some 25 Indians of the 80-acre Grindstone Rancheria.

USCE DOS RIOS PROJECT - SOUTHERN ROUTE

SCALE OF MILES
0 4 8 16 24

USCE Dos Rios Project -- Southern Route

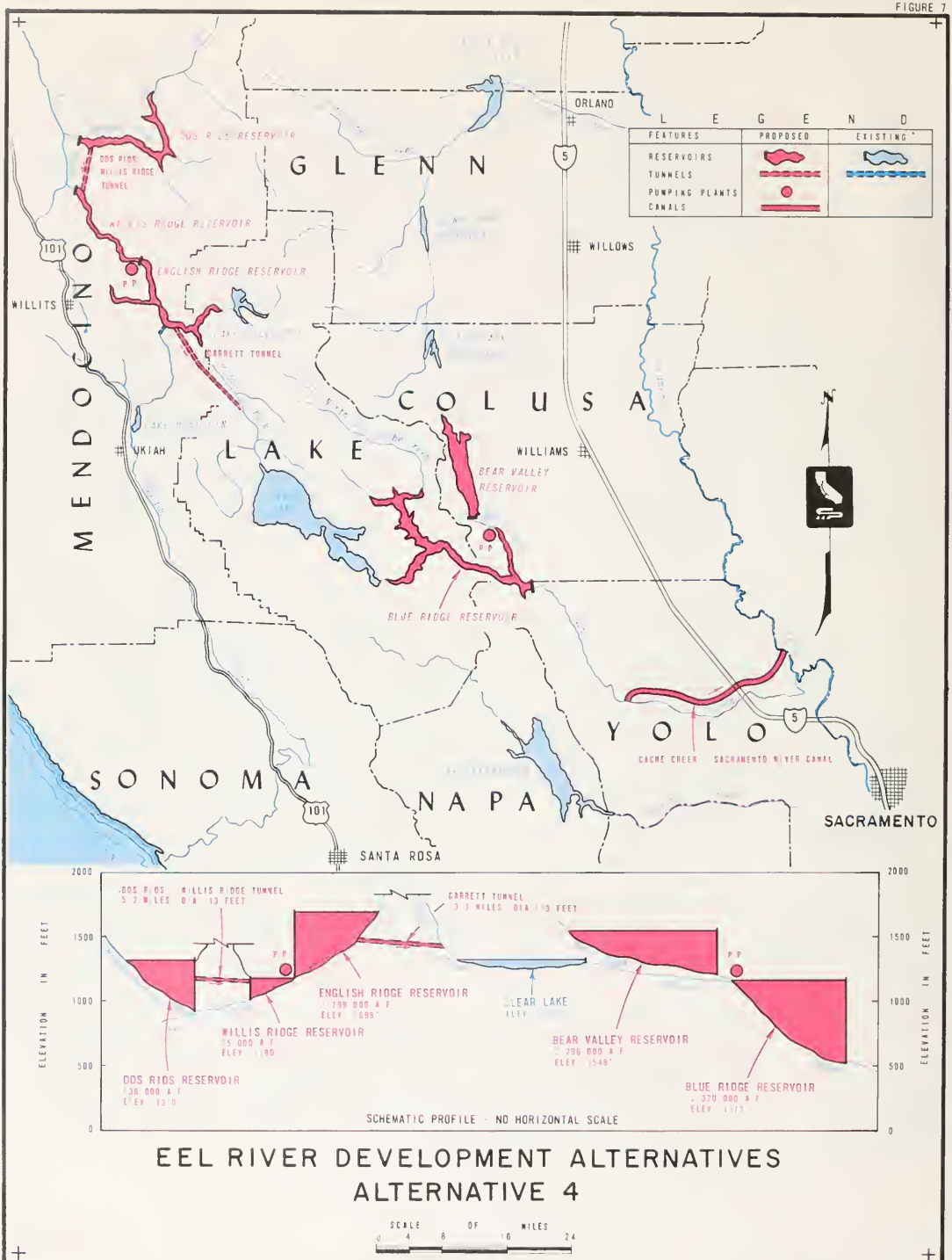
The Dos Rios Reservoir proposed by the Corps of Engineers with a southern diversion route through Clear Lake is not an alternative but is presented for comparative purposes only. Gravity releases would be made through a tunnel from Dos Rios Reservoir to Willis Ridge Reservoir on the upper Eel River. The 190-foot-high Willis Ridge Dam would form a constant-level forebay to back water to the toe of the 553-foot-high English Ridge Dam. Pumps would lift the water approximately 500 feet into English Ridge Reservoir from which it would flow by gravity to Clear Lake via the Garrett Tunnel and then down Cache Creek to the Cache Creek-Sacramento River Canal.

This system would produce a yield of 900,000 acre-feet per year, referenced to the Sacramento-San Joaquin Delta, plus an additional yield of 200,000 acre-feet per year for use locally. The 140,000 acre-feet of flood reservation in English Ridge Reservoir, along with the 600,000-acre-foot reservation in Dos Rios Reservoir, could have reduced the December 1964 flood peak to below the proposed 600,000-cubic-foot-per-second capacity of the authorized Eel Delta levees. When operated in conjunction with the Eel Delta levees, this project would have reduced the December 1964 flood peak at Scotia from 750,000 to 490,000 cubic feet per second. English Ridge and Willis Ridge Reservoirs would provide maximum annual recreation capacities of 2,200,000 and 400,000 recreation-days respectively in addition to the 2,000,000 recreation-day capacity of Dos Rios Reservoir. As presently formulated, the Dos Rios Reservoir plan would also provide for a minor amount of hydroelectric power generation.

The large Dos Rios Reservoir would inundate about 40,000 acres, including the 18,000-acre Round Valley. English Ridge and Willis Ridge Reservoirs would flood 12,800 acres of canyon lands. Dos Rios Reservoir would displace approximately 1,500 people, including many of the 350 Indians of the Round Valley Reservation; English Ridge and Willis Ridge Reservoirs would displace around 210 people. The three reservoirs of this system would cause a substantial effect on wildlife resources of the area, resulting in the need for extensive preservation efforts. They would inundate a total of 78 miles of river channel, increase summer flows in 125 miles of channel, and create a total of 430 miles of reservoir shoreline. Willis Ridge Dam would block salmon and steelhead runs estimated to average about 27,000 fish per year; this would necessitate preservation measures comparable to those required for the 36,000 fish per year at Dos Rios Dam.

The depth and volume of water in the reservoirs would facilitate control of temperature and turbidity of the downstream fishery preservation releases, as well as of the water diverted to Clear Lake. The potential quality of water diverted to Clear Lake, and its effect on the lake, are receiving additional study by the Department and by federal agencies. Because of the large sizes of Dos Rios and English Ridge Reservoirs in this plan, no difficulties are anticipated from sedimentation and landslides.

The illustrated project could be modified by the addition of a reservoir on Cache Creek. The Cache Creek Reservoir would allow a reduction in the size and cost of Garrett Tunnel; it would also provide flood protection on Cache Creek and allow modifications to be made which would reduce flood damages around Clear Lake. Within the context of this report, the addition of a reservoir on Cache Creek would have a very minor effect on project costs, but it should be given consideration in any future studies which take benefits into account.



EEL RIVER DEVELOPMENT ALTERNATIVES
ALTERNATIVE 4

SCALE OF MILES
0 4 8 16 24

Alternative 4: Small Dos Rios -- Southern Route

Alternative 4 would combine the 420-foot-high Dos Rios Dam of Alternative 1 with a southern diversion route through Clear Lake. Releases would flow by gravity from Dos Rios Reservoir to a constant-level reservoir behind a 190-foot-high Willis Ridge Dam. Pumps at the upstream end of Willis Ridge Reservoir would lift the water about 500 feet to English Ridge Reservoir, formed by a 553-foot-high dam. Releases would be made via the Garrett Tunnel through Clear Lake to Blue Ridge Reservoir, formed by a 675-foot-high dam on Cache Creek. Additional storage to meet dry-year needs would be obtained by pumping water up about 400 feet into a Bear Valley Reservoir formed by a 352-foot-high dam on Bear Creek, a tributary of lower Cache Creek. Releases from Blue Ridge and Bear Valley Reservoirs would be diverted from Cache Creek near Capay into the Cache Creek-Sacramento River Canal.

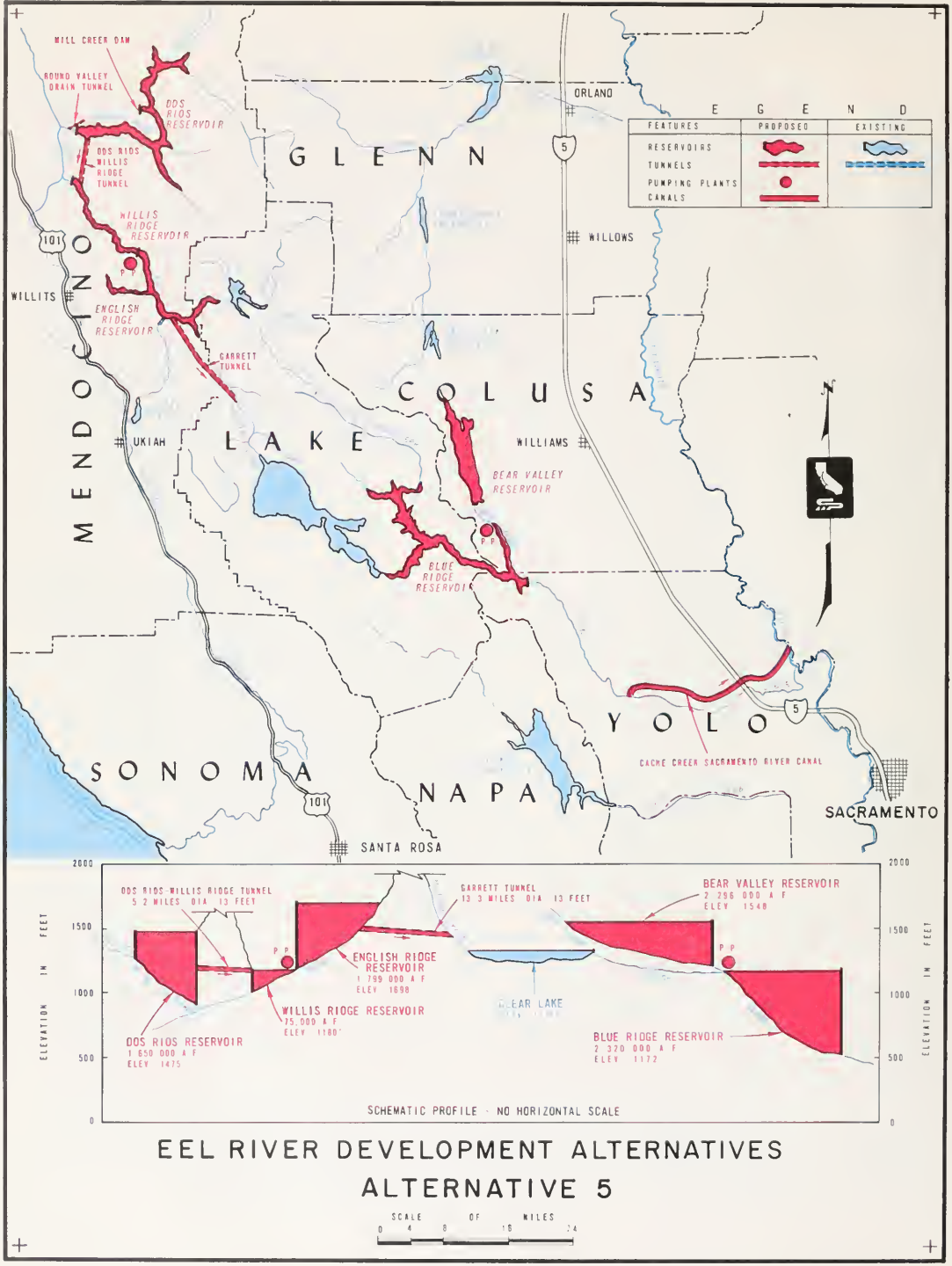
This plan would yield 900,000 acre-feet per year, referenced to the Sacramento-San Joaquin Delta, plus an additional yield of 200,000 acre-feet per year for use locally. The low Dos Rios Reservoir would be too small to include a specific flood control reservation and would have only an incidental effect on floods in the Eel River Delta. English Ridge Reservoir, as formulated by the Bureau of Reclamation, would have reduced the peak flow of the December 1964 flood at Fernbridge from 840,000 to 765,000 cubic feet per second and at Scotia from 750,000 to 660,000 cubic feet per second. Blue Ridge Reservoir would have 150,000 acre-feet of flood reservation which would be operated in conjunction with an enlarged Clear Lake outlet to provide flood protection around Clear Lake and on lower Cache Creek.

The maximum annual recreation use at the small Dos Rios Reservoir is estimated at 300,000 recreation-days. The constant-level Willis Ridge Reservoir, although smaller, would support an annual use of approximately 400,000 recreation-days. Use at English Ridge Reservoir is estimated to reach 2,200,000 recreation-days per year. Blue Ridge Reservoir would provide approximately 1,000,000 recreation-days annually and Bear Valley Reservoir would support some 500,000 recreation-days per year.

Precautions pertaining to sedimentation and landslides at the small Dos Rios Reservoir are presented under Alternative 1. Dos Rios Reservoir would necessitate preservation measures for runs of salmon and steelhead averaging 36,000 fish per year. English Ridge and Willis Ridge Reservoirs would flood some 12,800 acres of canyon lands, block an average of 27,000 salmon and steelhead from their natural spawning grounds, and result in substantial effects on wildlife resources. About 210 residents would be displaced. Within the Eel River Basin, the project reservoirs would inundate a total of 67 miles of major river channel, increase summer flows in 125 miles of main stream channel, and create 260 miles of reservoir shoreline. The potential quality of water released from English Ridge Reservoir to Clear Lake, and its effect on the lake, are receiving additional study by the Department and by federal agencies.

Blue Ridge Reservoir would inundate 14,200 acres along Cache Creek, cover 34 miles of stream channel, and create 190 miles of reservoir shoreline. About 60 persons presently live within the reservoir area, but some subdivision activity is under way in the upper reaches. Blue Ridge Reservoir would disturb substantial wildlife populations, including deer and elk, and extensive preservation measures would be necessary.

Bear Valley Reservoir would cover 14,200 acres of grazing and dry-farmed grain land in western Colusa County and create 50 miles of reservoir shoreline. The potential for irrigated agriculture is quite restricted due to limited crop adaptability. The population of the potential reservoir site is approximately 20 persons; the area is noted for its scenic beauty and spring wildflower displays.



EEL RIVER DEVELOPMENT ALTERNATIVES

ALTERNATIVE 5

SCALE OF MILES
0 4 8 16 24

Alternative 5: Medium-Sized Dos Rios -- Southern Route

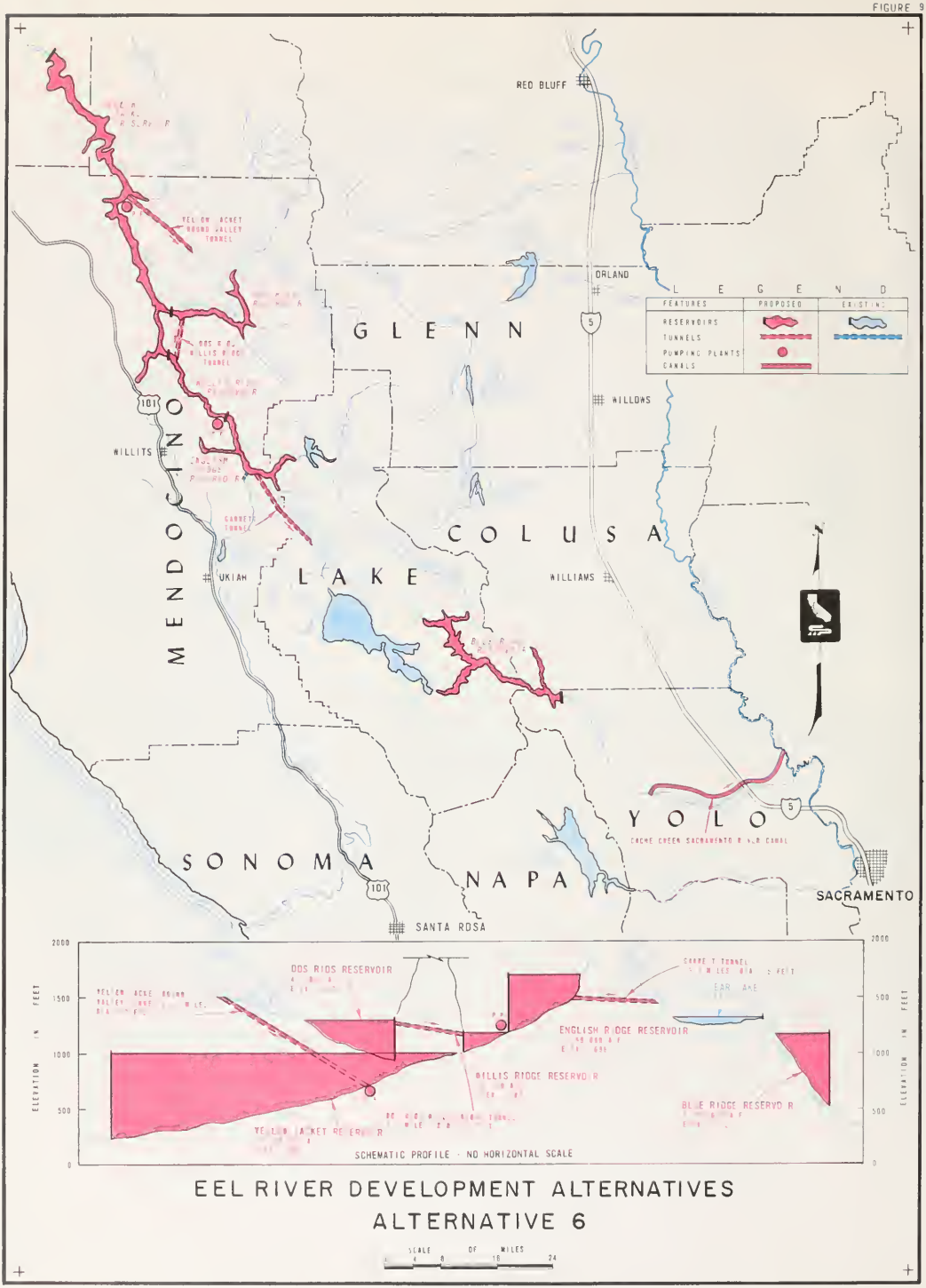
Alternative 5 would consist of a 605-foot-high Dos Rios Dam, with Round Valley excluded from the reservoir as in Alternative 2, combined with a southern diversion route through Clear Lake. The facilities along the conveyance route would be essentially the same as those in Alternative 4. A gravity tunnel would convey Dos Rios Reservoir water to Willis Ridge Reservoir, from which pumps would lift it about 500 feet to English Ridge Reservoir. Garrett Tunnel would convey the diverted water to Clear Lake. Releases from Clear Lake would be stored in Blue Ridge and Bear Valley Reservoirs. Stored water would be released back into Cache Creek during times of need and conveyed to the Sacramento River via the Cache Creek-Sacramento River Canal.

Alternative 5 has been formulated to yield 900,000 acre-feet per year, referenced to the Sacramento-San Joaquin Delta, plus an additional yield of 200,000 acre-feet per year for use in adjacent local areas. The 1,650,000-acre-foot Dos Rios Reservoir would include 600,000 acre-feet of specific flood reservation, the same as the Corps' proposed reservoir. English Ridge Reservoir would incorporate 140,000 acre-feet of flood reservation, and together the two reservoirs could have reduced the December 1964 flood peak to below the 600,000-cubic-foot-per-second capacity of the authorized Eel Delta levees. When operated in conjunction with the Eel Delta levees, this project would have reduced the December 1964 flood peak at Scotia from 750,000 to 490,000 cubic feet per second. The maximum recreation potential of Dos Rios Reservoir with Round Valley protected is estimated as 320,000 recreation-days per year. The expected maximum annual use in recreation-days at the other reservoirs in the system is the same as shown for Alternative 4: Willis Ridge, 400,000; English Ridge, 2,200,000; Blue Ridge, 1,000,000; and Bear Valley, 500,000.

The drainage tunnel shown for Round Valley would not be able to carry the estimated maximum instantaneous runoff from the valley, and some temporary ponding would result at the tunnel intake during major storms. Flowage easements would be acquired for land affected in this way. The tunnel could be made sufficiently large to avoid ponding in the lower end of Round Valley, but at much greater cost.

The medium-sized Dos Rios Reservoir would include 350,000 acre-feet of inactive storage capacity, which would be adequate to store the estimated sediment deposition and landslide debris for about 100 years. The 700,000 acre-feet of conservation storage would provide a safety factor against an underestimation of debris volume, a factor which would not exist with the small Dos Rios Reservoir.

The medium-sized Dos Rios Reservoir would inundate about 10,400 acres of canyon lands and necessitate preservation measures for runs of salmon and steelhead averaging 36,000 fish per year. The reservoir would have far less effect on wildlife resources than a reservoir which included Round Valley. It would displace about 50 persons. The project reservoirs within the Eel River Basin would inundate a total of 73 miles of major river channel, increase summer flows in 125 miles of channel, and create 270 miles of reservoir shoreline. The discussions under Alternative 4, pertaining to Willis Ridge, English Ridge, Blue Ridge, and Bear Valley Reservoirs, and to Clear Lake, are also applicable to this alternative.



EEL RIVER DEVELOPMENT ALTERNATIVES
ALTERNATIVE 6

Alternative 6: Yellow Jacket -- Southern Route

In Alternative 6, a 780-foot-high Yellow Jacket Dam would be constructed to form a 10,380,000-acre-foot reservoir on the lower Eel River. As in Alternative 3, an underground pumping plant near the mouth of the North Fork Eel River would lift the reservoir water about 800 feet through an 11.1-mile tunnel to Mill Creek, above the northwest corner of Round Valley. Mill Creek would carry the diversions through the valley to a reservoir formed by a 400-foot-high Dos Rios Dam. From Dos Rios Reservoir, water would be conveyed south with the same features used for Alternatives 4 and 5: Willis Ridge Reservoir, a pumping plant to English Ridge Reservoir, the Garrett Tunnel to Clear Lake, Blue Ridge Reservoir, and the Cache Creek-Sacramento River Canal. Because of the large storage available in Yellow Jacket Reservoir, Bear Valley Reservoir would not be needed.

Alternative 6 would provide 790,000 acre-feet per year of new yield, in addition to an annual yield of 900,000 acre-feet referenced to the Sacramento-San Joaquin Delta. Part of the new yield would be committed to future use in adjacent local areas and the remainder would be available for use in other areas of the State. The illustrated Yellow Jacket Reservoir would include a specific flood reservation of 900,000 acre-feet; when operated with the proposed Eel Delta levees, the reservoir would provide protection from floods much larger than that which occurred in December 1964. When operated in conjunction with the Eel Delta levees, this project would have reduced the December 1964 flood peak at Scotia from 750,000 to 490,000 cubic feet per second.

The maximum recreation use of Yellow Jacket Reservoir is estimated to reach 2,100,000 recreation-days annually. The expected maximum annual use in recreation-days at the other reservoirs in the system is the same as shown for Alternative 4: Dos Rios, 300,000; Willis Ridge, 400,000; English Ridge, 2,200,000; and Blue Ridge, 1,000,000.

The Yellow Jacket Reservoir shown in this alternative would flood about 37,500 acres of Eel River canyon lands and displace about 420 permanent residents. It would necessitate relocation of about 93 miles of the Northwestern Pacific Railroad from Willits to the mouth of the South Fork Eel River. The reservoir would be large enough to minimize any potential operation difficulties from sediment deposition or landslide debris.

About half the salmon and steelhead spawning in the Eel River Basin takes place upstream from Yellow Jacket Dam site. The runs at the damsite are estimated to average 104,000 fish per year, about three times the size of the runs at Dos Rios Dam site. The four Eel River Basin reservoirs required for this plan would flood out a total of 127 miles of major river channel, increase summer flows in 59 miles of channel, and create 480 miles of reservoir shoreline. Major preservation measures would be necessary to prevent serious fishery losses, and large downstream releases would be needed for fishery preservation. Substantial efforts would also be required for wildlife preservation.

The Dos Rios Reservoir included in this alternative would not encroach upon Round Valley. It would have a very limited active storage capacity and would be subject to the same problems as the low reservoir shown in Alternatives 1 and 4.

The discussion under Alternative 4, pertaining to Willis Ridge, English Ridge, and Blue Ridge Reservoirs, and to Clear Lake, are also applicable to this alternative.

SUMMARY OF SECONDARY ALTERNATIVES

A number of variations of the principal alternatives, as well as several separate alternatives, were analyzed during the investigation. The variations (Nos. 1A, 1B, 4A, and 4B) involved the addition of Spencer Reservoir on the Middle Fork Eel River, or Mina Reservoir on the North Fork Eel River, to those alternatives involving a small Dos Rios Reservoir. The separate alternatives (Nos. 7 through 12) involved a Spencer Reservoir, Spencer and Mina Reservoirs together, Indian Springs Reservoir, or Upper Island Mountain Reservoir, the latter two on the lower Eel River. Table 3 summarizes these secondary alternatives and explains why they were not included among the principal alternatives. The locations of the various damsites are shown on Figure 1 (opposite page 1).

Spencer Dam site is located near the upper end of the proposed Dos Rios Reservoir, about 11 miles northeast of Dos Rios Dam site. It was investigated during the studies leading to the Department's Bulletins No. 136, "North Coastal Area Investigation", and No. 171, "Upper Eel River Development -- Investigation of Alternative Conveyance Routes". Present indications are that the geologic conditions at Spencer Dam site are questionable for a high dam, but that the site is adequate for further consideration of a dam up to about 360 feet high. This size limitation would permit construction of a reservoir with a gross capacity of 450,000 acre-feet.

Mina Dam site is located on the North Fork Eel River, about 17 miles north of the Dos Rios Dam site. It is presently under investigation by the U. S. Bureau of Reclamation for reservoirs of up to approximately 800,000 acre-feet gross storage.

Indian Springs Dam site is located on the Eel River just downstream from the mouth of the Middle Fork, about 4 miles northwest of Dos Rios Dam site. A 515-foot-high Indian Springs Dam would form a 1,750,000-acre-foot reservoir reaching to the extreme lower ends of both Round Valley and Little Lake Valley. Surficial geologic examinations of this site indicate that the foundation is weak, especially in the channel area where a major shear zone is believed to exist. In addition, there are extensive landslides on the right abutment. The Department has concluded that these problems preclude further consideration of a high dam at this site.

Upper Island Mountain Dam site is located on the Eel River about 20 miles downstream from Indian Springs Dam site. Its location about 3 miles downstream from the mouth of the North Fork Eel River would allow it to develop substantially all of the runoff which would be available at Yellow Jacket Dam site farther down the river. However, investigation by the Department during this study showed that the Upper Island Mountain site is unsuitable for construction of a high dam. Much of the foundation rock is sheared and crushed to such a degree that the integrity of the foundation is questionable; in addition, landslides and deep overburden cover much of the damsite and adjacent areas. For these reasons, further study of alternatives involving an Upper Island Mountain Reservoir was abandoned.

Previous studies of the lower Eel River have identified other damsites which are alternatives to those already described. All have been rejected for one reason or another. The Woodman and Bell Springs sites were alternatives to Indian Springs Dam site in the river reach between Dos Rios and the mouth of the North Fork Eel River. Both of these sites have been passed over because of adverse foundation conditions. Sequoia Dam site, on the lower Eel River just above the mouth of the South Fork, has been rejected because the nearby Yellow Jacket site appears to be superior.

TABLE 3
SUMMARY OF SECONDARY ALTERNATIVES

	PROJECT	PHYSICAL FEATURES: RESERVOIRS Capacity in Million Acre-Feet	PHYSICAL FEATURES: TUNNELS	REASONS FOR EXCLUSION FROM LIST OF PRINCIPAL ALTERNATIVES
Eastern Diversion Route	Alternative 1A *	Spencer 0.45 Oos Rios 0.54 Rancheria 5.00	Grindstone	Increases yield of Principal Alternative 1 by 50,000 acre-feet per year, but at a high incremental unit cost; adds no significant flood control potential.
	Alternative 1B *	Mina 0.55 Oos Rios 0.54 Rancheria 5.44	Mina-Williams Creek Grindstone	Increases yield of Principal Alternative 1 by 170,000 acre-feet per year, but at a high incremental unit cost; adds no significant flood control potential.
	Alternative 7	Spencer 0.45 Rancheria 5.45 Paskenta 0.13 Black Butte (existing) 0.16	Spencer-Grindstone	Is more costly than Principal Alternative 1 and provides no significant flood control potential. Precludes development of Paskenta-Newville Project on Thomes and North Fork Stony Creeks because these streams are developed in this alternative.
	Alternative 8	Mina 0.55 Spencer 0.45 Rancheria 5.00	Mina-Williams Creek Spencer-Grindstone	Would cost from $100 to $200 million more than the eastern route Principal Alternatives Nos. 1, 2, and 3 and provides no significant flood control potential.
	Alternative 9	Indian Springs 1.75 Rancheria 5.43	Grindstone	Major shear zone in channel at Indian Springs Dam site and massive landslide on right abutment precludes consideration of a high dam.
	Alternative 10	Upper Island Mountain 4.78 Oos Rios 0.44 Rancheria 6.10	Grindstone	Upper Island Mountain Dam site is unsuitable for construction of a high dam (737 feet). Foundation rock is sheared and crushed and landslides and deep overburden mantle much of the damsite.
Southern Diversion Route	Alternative 4A **	Spencer 0.45 Oos Rios 0.54 Willis Ridge 0.08 English Ridge 1.80 Blue Ridge 2.32 Bear Valley 2.30	Oos Rios-Willis Ridge Garrett	Increases yield of Principal Alternative 4 by 40,000 acre-feet per year, but at a high incremental unit cost; adds no significant flood control potential.
	Alternative 4B **	Mina 0.84 Oos Rios 0.54 Willis Ridge 0.08 English Ridge 1.80 Blue Ridge 2.32 Bear Valley 2.30	Mina-Williams Creek Oos Rios-Willis Ridge Garrett	Increases yield of Principal Alternative 4 by 160,000 acre-feet per year, but at a high incremental unit cost; adds no significant flood control potential.
	Alternative 11	Indian Springs 1.75 English Ridge 1.80 Blue Ridge 4.25	Garrett	Major shear zone in channel at Indian Springs Dam site and massive landslide on right abutment precludes consideration of a high dam.
	Alternative 12	Upper Island Mountain 6.65 Willis Ridge 0.08 English Ridge 1.80 Blue Ridge 4.25	Garrett	Upper Island Mountain Dam site is unsuitable for construction of a high dam (795 feet). Foundation rock is sheared and crushed and landslides and deep overburden mantle much of the damsite.

* Projects 1A and 1B are variations of Principal Alternative 1.
** Projects 4A and 4B are variations of Principal Alternative 4.

INVESTIGATION GUIDELINES

Ideally, each alternative to the Corps of Engineers' Dos Rios Project would provide the same flood control, recreation, and water supply as the Corps' project. However, since physical and economic limitations preclude meeting such a criterion, a modified definition of "alternative" was adopted.

For purposes of this study, an alternative project would produce a dry-period water yield at the Sacramento-San Joaquin Delta at least equivalent to the 900,000 acre-feet which could be produced by the Corps' Dos Rios Project. Local needs of 200,000 acre-feet per year in and adjacent to the Eel River Basin would also be served by the southerly diversion route alternatives.

For most of the alternatives examined, these project yield criteria correspond closely to the optimum yield capabilities of the feature involved. Thus, formulating the projects to produce identical yields to facilitate comparison of alternatives does not introduce significant distortions in overall project economics. However, this does not hold true for projects involving dams on the lower Eel River. There the runoff is much greater and the projects would be seriously underdeveloped if they were formulated to yield only 900,000 or 1,100,000 acre-feet per year. For this reason, the alternatives involving lower Eel River reservoirs are sized consistent with full development of their water supplies. Although this procedure does not allow direct comparison with other alternatives, the scales of development illustrated are representative of those which should be constructed under the concept of optimization of resource development.

Flood Control

Insofar as practical, each alternative was formulated to provide at least the same flood control as the Corps' Dos Rios Project. Provision was made for inclusion of specific flood control storage reservations where feasible. With the low incremental cost of storage in the large Dos Rios Reservoir with Round Valley storage, the Corps found that 600,000 acre-feet of flood control reservation was justifiable. For the small Dos Rios Reservoirs considered in this investigation, the limited amount of storage available would preclude the inclusion of any specific flood reservation, although some incidental flood protection would be afforded by the normal operation of the reservoir. With the intermediate sizes of Dos Rios Reservoir (with Round Valley protected), projects were formulated to provide flood protection approximately equivalent to that which would be provided by the Corps' Dos Rios Reservoir plan. A large reservoir on the lower Eel River would be able to provide substantially greater flood protection than any Dos Rios Project.

Flow reductions of the 1964 Eel River flood peak at the Scotia gaging station and at Fernbridge in the Eel Delta were chosen to illustrate the comparison of flood control potential of the various alternatives. Recommended flood storage reservations, peak reductions, and other flood control parameters for reservoirs in the Eel River Basin and the Sacramento Valley were furnished by the Corps of Engineers.

Recreation

Estimates of recreation use and costs for all reservoirs in this study were furnished by the Department of Parks and Recreation. For some of the reservoirs, this information was available from previous detailed studies; for those remaining, new cursory-level estimates were prepared. The recreation studies were coordinated with the U. S. Bureau of Outdoor Recreation and the Corps of Engineers.

Fish and Wildlife

Data on fish and wildlife affected by the various alternatives were furnished by the Department of Fish and Game. These data included estimates of anadromous fish runs at the various damsites, estimates of the necessary flow releases for fisheries preservation, information on fish hatchery sizes and costs, and data on lands and costs required for wildlife preservation. These data were also furnished to the U. S. Fish and Wildlife Service. Many of these estimates are based on preliminary information and are subject to change as more detailed studies are made. Only the major cost items were estimated and some additional, but as yet unidentified, preservation requirements may be necessary. There is potential for the enhancement of anadromous fish in the Eel River Basin, but not enough information is available to warrant inclusion of fisheries enhancement as a project purpose at this time.

Water Quality

The mineral quality of the water of the Eel River is excellent. However, the water does contain sufficient nutrients to permit algae growth in both impounding reservoirs and in reservoirs into which Eel River water is diverted. Natural turbidity of the Eel River waters could also be troublesome in reservoirs as well as in downstream releases for fishery preservation. The temperature of reservoir diversions and releases has an effect on the fishery, recreation use, and algae growth. Prediction of the effects of a project on water quality depends on complex studies of detailed operation schedules for the various features in a system. These predictions have not been made for the alternatives covered by this report, but some general conclusions may be drawn. With proper location and design of intake facilities, and careful operation of the reservoir, the problems related to nutrients, turbidity, and temperature could be avoided or minimized. In general, the degree of control over these variables is greater in the larger reservoirs.

Conveyance and storage of water along the proposed southern diversion route could be affected by boron and nutrients such as phosphorous and nitrogen. The Department of Water Resources is continuing studies of water quality within these areas potentially affected by Eel River developments. Special attention is being given to Clear Lake and the resultant effect of Eel River imports. A board of consultants is assisting the Department of Water Resources in these studies.

Economic Criteria

Since the first need for additional water supplies by the State Water Project is projected to occur in 1986, the 100-year period from 1986 through 2085 was selected as the basis for analysis. The Department's current planning interest rate of 5 percent per year was adopted; this required conversion of the Corps' Dos Rios Project analysis from its original 3.25 percent interest rate to permit comparison.

The analyses of alternatives were based on staging plans which would allow the various dams and tunnels to be constructed as late as possible and still meet the water demands.

The comparison of alternatives is based on project costs only; no benefit evaluations or cost allocations were made. No attempt was made to differentiate between potential state and federal expenditures, even though the extent of federal participation could have a major impact on the attractiveness of the alternatives from the State's viewpoint.

Cost Estimates

For comparative purposes, all cost estimates used in this investigation were referenced to July 1969 price levels. The effects of future cost escalation are not reflected.

Most of the features included in the alternative plans have been studied previously in connection with the investigations which led to the initial choice of the Dos Rios Project. At the beginning of this study of alternatives, the Department was just completing additional surface geologic studies of southern route diversion tunnels and of the major damsites on Cache Creek. This work was accelerated to provide new cost estimates of these features. The Department also prepared cost estimates for all other tunnels and pumping plants.

The Corps of Engineers furnished preliminary cost estimates for Yellow Jacket Dam and Reservoir and independently formulated various alternative proposals. The Bureau of Reclamation provided estimates for the English Ridge Project and Mina Dam and Reservoir.

The firm of Bechtel, Incorporated, was retained to evaluate the sites and prepare independent cost estimates for Blue Ridge, Bear Valley, and Mill Creek Dams, and the Grindstone Tunnel. The costs shown in Table 1 reflect these estimates.

Geologic Conditions

The Eel River watershed consists of steep, mountainous terrain, covered by unstable soils. The underlying Franciscan Formation is often intensely sheared and fractured and areas of competent hard rock are of limited extent. The geologist's surface evaluations are complicated by extensive areas of deep overburden and landslide debris which obscure the evidence of underground conditions. As a result, intensive investigations are required in the planning and design of major structures in the Eel River area. To an extent, similar conditions exist in the Cache Creek Basin.

The damsites and tunnel locations illustrated in the principal alternatives in this report have generally been investigated sufficiently to give a reasonable degree of confidence in them. However, it would be imprudent to select a specific alternative for development without first conducting intensive field investigations to thoroughly define problems associated with it.

One of the most significant features of the Eel River Basin is the presence of numerous and extensive landslides. Any reservoir in the basin would contact many of these slides and its storage capacity could gradually be impaired as the slide material slowly moved in. To better define the potential problems, the Department has been investigating landslides on the Middle Fork Eel River since 1966. Preliminary results indicate that the possibility of a rapid landslide is negligible and that the storage loss to slow-moving landslide debris would not be serious with a large Dos Rios Reservoir. However, the potential effect on a small reservoir is much more severe; any substantial underestimation of the landslide volume could have a major effect on the project feasibility and future costs. Much more intensive landslide investigations would be essential if future attention were to be focused on a small Dos Rios Reservoir.

The Eel River carries extremely high sediment loads, most of which will be deposited in the proposed reservoirs. Recent investigations of sediment production within the Eel River Basin by the United States Soil Conservation Service and the Geological Survey indicate that deposition would not constitute a serious problem in large reservoirs. However, the threat to small reservoirs such as the low Dos Rios Reservoir is similar to that posed by landslides; an underestimation of the sediment yields could adversely affect the feasibility of the project.

The unstable geologic conditions, coupled with post-project reduction of flood flows, could cause fisheries problems in downstream areas. Spawning habitat could be lost through sedimentation, cementation, gravel compaction, and the encroachment of riparian vegetation. If main stream flushing flows were greatly reduced, bedload debris from tributary streams could choke pools in the main channel, and upstream migration of salmon and steelhead could be temporarily blocked by landslides. Generally speaking, the prospect of these problems occurring would be reduced with smaller upstream projects and increased with larger ones. All potential problems must be defined and solutions carefully analyzed to keep such downstream effects to a minimum.

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